

# REVISION OF *PYLOPAGURUS* AND *TOMOPAGURUS* (CRUSTACEA: DECAPODA: PAGURIDAE), WITH THE DESCRIPTIONS OF NEW GENERA AND SPECIES:

PART II. *RHODOCHIRUS* MCLAUGHLIN and  
*PHIMOCHIRUS* MCLAUGHLIN

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## ABSTRACT

In this second of a six part series, the recently established genera *Rhodochirus* and *Phimochirus* and their respective species are diagnosed more fully and illustrated. Keys to the species are presented and a new species of *Phimochirus* is described.

In part I of the revision of the pagurid genera *Pylopagurus* and *Tomopagurus* (McLaughlin, 1981), the former genus was restricted to those species typified by its type species, *Pylopagurus discoidalis* (A. Milne Edwards), and 10 new genera were erected for the remaining score of species. In this second of the six part series, the genera *Rhodochirus* and *Phimochirus* and their respective species are diagnosed in greater detail and one new species of *Phimochirus* is described.

## MATERIALS

Specimens included in part II have come from the collections of the Allan Hancock Foundation, University of Southern California (AHF), the Bermuda Biological Station (BBS), Dauphin Island Sea Lab, University of Alabama (DISL), Florida State Department of Natural Resources (DNR), Instituto de Investigaciones Marinas de Punta de Betín, Santa Marta, Colombia (INVEMAR), Museum of Comparative Zoology, Harvard University (MCZ), Museum National d'Histoire Naturelle, Paris (MNHN), National Museum of Natural History, Smithsonian Institution (USNM), National Marine Fisheries Service (NMFS), Rosenstiel School of Marine and Atmospheric Science, University of Miami (RSMAS) UMML, Smithsonian Institution, Fort Pierce Bureau, Ft. Pierce, FL (SIFPB), University of Wisconsin (UW) and several individual collectors. Specimens have been deposited at these institutions and at Florida International University (FIU).

## *Rhodochirus* McLaughlin, 1980

*Pylopagurus*: A. Milne Edwards and Bouvier, 1893: 74 (in part).—Walton, 1954: 140 (in part).—Forest and de Saint Laurent, 1968: 145 (in part). Not *Pylopagurus* A. Milne Edwards and Bouvier, 1891.

*Rhodochirus* McLaughlin, 1981: 3. Type species, by original designation: *Pylopagurus rosaceus* A. Milne Edwards and Bouvier, 1893. Gender: Masculine.

**Diagnosis.**—Eleven pairs of phyllobranch gills. Ocular acicles triangular, with small to moderately large submarginal spine; usually separated basally by basal width or less of 1 acicle. Sternite of 3rd maxillipeds unarmed or with very small denticles on either side of midline. Third maxillipeds each with well developed crista dentata with prominent accessory tooth; merus with or occasionally without small spine at dorsodistal margin. Maxillule with internal lobe of endopod moderately well developed and with 1 to 3 stiff bristles terminally; external lobe produced, not recurved.

Right cheliped with chela subovate to subquadrate; dorsal surface with at least some spines or tubercles with basal rosettes and often with clusters of simple rosettes; angle of articulation of chela and carpus approximately 15° from perpendicular. Left cheliped with chela usually moderately broad; dorsal surface

with clustered rosettes and/or spines with basal rosettes laterally; angle of articulation of chela and carpus  $45^{\circ}$ – $75^{\circ}$  from perpendicular. Carpus triangular in cross-section.

Anterior lobe of sternite of 3rd pereopods semisubcircular to semisubquadrate, often slightly skewed. Sternites of pereopods 3 to 5 often with capsulate setae, particularly in males.

Fourth pereopods with propodal rasp consisting of single row of corneous scales; dactyl well developed, claw usually elongate, curved; preungual process well developed on lateral face near base of claw.

Males and females both with paired gonopores; males without sexual tubes.

Abdomen typically flexed. Males normally without paired pleopods, but with 3 unpaired biramous pleopods with reduced endopods. Females with paired 1st pleopods modified as gonopods, and with 4 unpaired biramous pleopods, 2nd–4th with both rami well developed, 5th with endopod reduced. Uropods asymmetrical. Telson with transverse suture; posterior lobes asymmetrical, usually triangular, with terminal margins oblique and armed with 1 to 4 strong calcareous spines and occasionally also with few smaller spines.

*Distribution*.—Western Atlantic from North Carolina to Florida, eastern Gulf of Mexico, Caribbean, Brazil; eastern Pacific from south end of Gulf of California to northern Peru, Cocos and Galapagos Islands; 36–200 m.

*Etymology*.—*Rhodochirus* is from the Greek *rhodon* meaning a rose and *cheir* meaning hand and refers to the rosette-like ornamentation of the chelae of the species assigned to this genus.

#### KEY TO THE SPECIES OF *RHODOCHIRUS*

- 1a. Right and left chelae each with numerous low spines with basal rosettes on dorsal surface of fixed finger; right chela with palm armed with moderately strong spines bearing basal rosettes  
----- *R. rosaceus*
- 1b. Right and left chelae each with numerous basal rosettes lacking spines on dorsal surface of fixed finger; right chela with palm armed with strong spines generally lacking basal rosettes  
----- *R. hirtimanus*

#### *Rhodochirus rosaceus* (A. Milne Edwards and Bouvier, 1893)

Figures 1a, 2a, 3a

*Pylopagurus rosaceus* A. Milne Edwards and Bouvier, 1893: 97, pl. 7, figs. 10–17 (type locality: off Grenada, BLAKE station 253).—Alcock, 1905: 189.—Hay and Shore, 1918: 413, pl. 30, fig. 5.—Gordan, 1956: 340.—Williams, 1965: 135, fig. 111.—Forest and De Saint Laurent, 1968: 150.

*Pylopagurus acutus* Forest and De Saint Laurent, 1968: 148, figs. 114, 120–123 (type locality: off Brazil, CALYPSO station 138,  $24^{\circ}43'S$   $45^{\circ}10'W$ ).

*Rhodochirus rosaceus*: McLaughlin, 1981: 4.

*Holotype*.—♀ (SL = 5.5 mm) MCZ 4094.

*Material Examined*.—See Table 1.

*Diagnosis*.—Shield approximately as long as wide, occasionally slightly wider; rostrum triangular or broadly rounded, usually without terminal spine; lateral projections obtusely triangular, with weak to moderately strong submarginal spine. Ocular peduncles moderately long, with corneae slightly dilated; ocular acicles acutely triangular, with strong submarginal spine; separated basally by four-fifths to entire basal width of 1 acicle. First segment of antennal peduncle sometimes with small spine laterally. Right cheliped with ventral margins of merus armed with blunt or acute spines; carpus with row of spines on dorsomesial margin, dorsal surface with numerous small spines; chela and dactyl with dorsal

surfaces armed with closely set acute or blunt spines, each with basal rosette, dorsomesial and dorsolateral margins with row of moderately strong spines. Left chela with blunt or acute spines on ventral margins of merus; carpus triangular with row of strong spines on dorsal margin; dorsal surfaces of palm and fixed finger with closely spaced acute, subacute or blunt spines, each usually with basal rosette. Dactyls of 2nd and 3rd pairs of pereopods each with rows of corneous spines on dorsal and ventral margins and mesial face; dorsal surfaces of propodi with low protuberances and stiff setae or bristles; carpi each with single spine on dorsodistal margin. Sternite of 3rd pereopods with anterior lobe semisubquadrate to semisubcircular. Sternites of 3rd, 4th and 5th pereopods sometimes with capitate setae. Telson with terminal margins oblique, armed with 1–3 strong acute spines.

*Distribution*.—South of Cape Lookout, North Carolina to Key West, Florida; northwestern Gulf of Mexico; Grenada, Surinam and Brazil; 95–200 m.

*Remarks*.—Forest and De Saint Laurent (1968) described *Pylopagurus acutus* from a single male specimen, which lacked the right cheliped, collected by the CALYPSO off Brazil. Having compared the descriptions and figures given by Hay and Shore (1918) and Williams (1965) for specimens they identified as *Pylopagurus rosaceus*, Forest and De Saint Laurent (1968) questionably placed the former authors' specimens in synonymy with *P. acutus*, and cited several characters which could be used to distinguish these specimens from Milne Edwards and Bouvier's *P. rosaceus* sensu stricto. Among these characters were the shape and development of the rostrum and lateral projections, the length of the ocular peduncles and dilation of the corneae and particularly the ocular somite which reportedly was “. . . complètement caché par ses écailles, qui sont contiguës.” It is now quite clear, having examined the type specimen in question, that Milne Edwards and Bouvier's (1893) description was based on a damaged specimen, although their illustration of the cephalothorax (pl. 7, fig. 10) does not reflect this condition. The right side of the shield is cracked and the right lateral projection folded under; the right ocular acicle is displaced so that upon casual observation it would appear as if it were contiguous with the left, although in actuality it is not. As previously mentioned, the right cheliped is missing from the holotype of *P. acutus*. However, from personal examination, I have found that in all other characters this specimen falls within the range of variation observed for *R. rosaceus*. Therefore, *P. acutus* must be considered a junior synonym of *R. rosaceus*.

*Rhodochirus hirtimanus* (Faxon, 1893)

Figures 1b, 2b, 3b

*Pylopagurus hirtimanus* Faxon, 1893: 170 (type locality: off Cocos Island, SW of Costa Rica, ALBATROSS station 3367); 1895: 65, pl. 13, figs. 1–1e.—Alcock, 1905: 190.—Walton, 1954: 158.

*Pagurus pollexcavus* Glassell, 1937: 261 (type locality: off Gorda Point, Baja California, Mexico 23°02'N 109°27.5'W).

*Rhodochirus hirtimanus*: McLaughlin, 1981: 4 (by implication).

*Lectotype*.—♂ (SL = 4.5 mm) USNM 21666, herein selected.

*Material Examined*.—See Table 2.

*Diagnosis*.—Shield approximately as long as broad or slightly broader; rostrum broadly triangular, usually without terminal spine; lateral projections triangular and with small marginal or submarginal spine. Ocular peduncles moderately long, somewhat constricted medially, and with corneae slightly dilated; ocular acicles

Table 1. *Rhodochirus rosaceus* (A. Milne Edwards & Bouvier) material examined

Locality	Depth (m)	Station Deposition	Date	Sex		SL (mm)	Collector
				♂	♀		
Western Atlantic							
35°06'00"N 75°08'30"W	183	Silver Bay 1635 UMML 32:4960	23/2/60	1		5.8	NMFS
30 mi. S. Cape Lookout, N.C.	—	— USNM 51046	—	1	1	5.4, 5.7	U.S. Bureau Fisheries
33 mi. S. Cape Lookout, N.C.	—	— USNM 102719	/15		1	2.3	U.S. Bureau Fisheries
Gulf of Mexico							
29°34'59"N 87°20'07"W	95	2645 DISL	8/2/78		1	5.1	DISL
29°34'58"N 87°20'00"W	106	2645 DISL	8/9/77		1	3.3	DISL
26°26'45"N 84°19'00"W	183	I DISL	2-3/76	1	1	6.2, 7.0	DISL
26°25'30"N 84°20'00"W	183	I DISL	7/27/75		1	7.4	DISL
26°24'40"N 84°19'50"W	186	0004 DISL	2/3/78	1	1	5.5, 6.9	DISL
Caribbean Sea							
27°46'00"N 94°13'00"W	366	Oregon 4614 UMML 32:4957	1/20/64		1	5.4	NMFS
24°39'30"N 80°40'00"W	201	Gerda 813 UMML 32:4964	6/21/67	1		3.6	RSMAS
13°10'12"N 61°05'30"W	108-183	Pillsbury 875 AHF	7/6/69		1	5.5	RSMAS
11°30'00"N 60°14'30"W	—	Pillsbury 845 FTU	7/1/69		1	5.6	RSMAS

Table 1. Continued

Locality	Depth (m)	Station Deposition	Date	Sex		SL (mm)	Collector
				♂	♀		
11°23'00"N 73°33'30"W	45–51	Oregon 4904 UMML 32:4958	5/28/64	1		5.9	NMFS
11°22'00"N 61°46'12"W	137–143	Pillsbury 848 FIU	7/29/69	1		6.0	RSMAS
11°19'42"N 62°01'12"W	121–131	Pillsbury 479 UMML 32:4963	8/3/66	2		5.8, 6.1	RSMAS
Off Grenada	168	Blake 253 MCZ 4094	—		1	5.8	U.S. Coast Survey
Southwestern Atlantic							
7°25'00"N 54°35'00"W	137–146	Oregon 2289 USNM 103418, AHF	9/8/58	11	4	3.8–4.8	NMFS
24°43'S 45°10'W	97–100	Calypso 138 MNHN		1		5.0	

Table 2. *Rhodochirus hirtimanus* (Faxon) Material examined

Locality	Depth (m)	Station Deposition	Date	Sex		SL (mm)	Collector
				♂	♀		
Gulf of California							
Inner Gorda Bank	128–146	Velero III 1035–40 AHF	1/20/40	1	1	5.7, 6.0	AHF
Eastern Pacific							
Off Cocos Island	183	Albatross 3367 USNM 21666, 172991, MCZ	2/28/90	8	6	3.1–5.9	U.S. Coast Survey

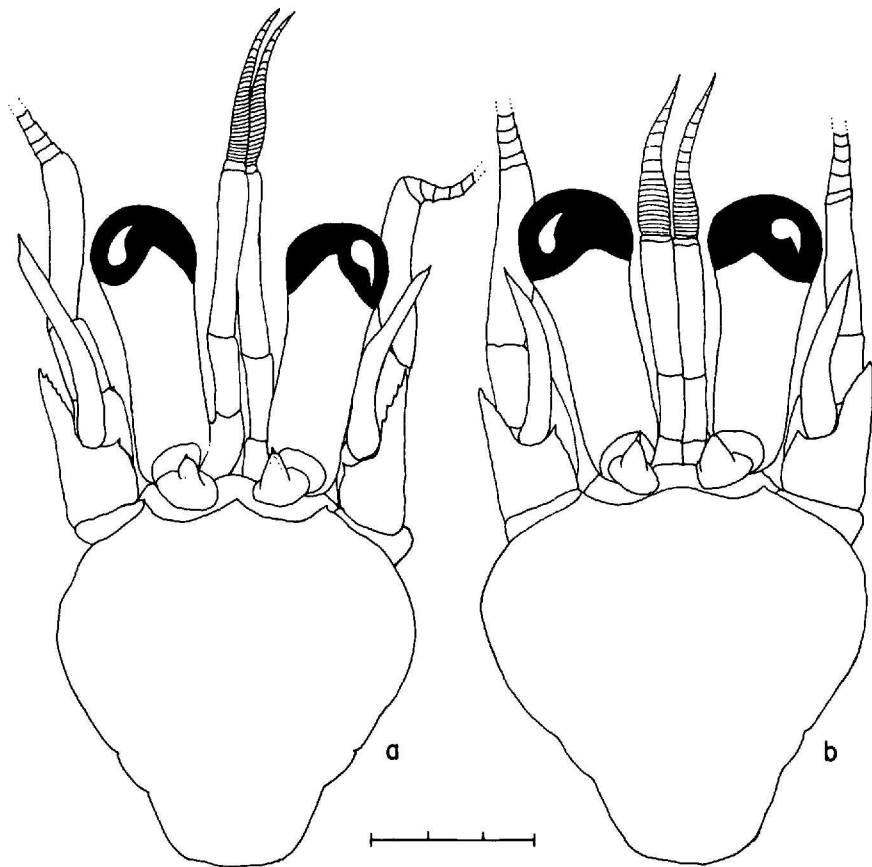


Figure 1. Diagrammatic shield and cephalic appendages: (a) *Rhodochirus rosaceus*; (b) *Rhodochirus hirtimanus*. Scale equals 3 mm.

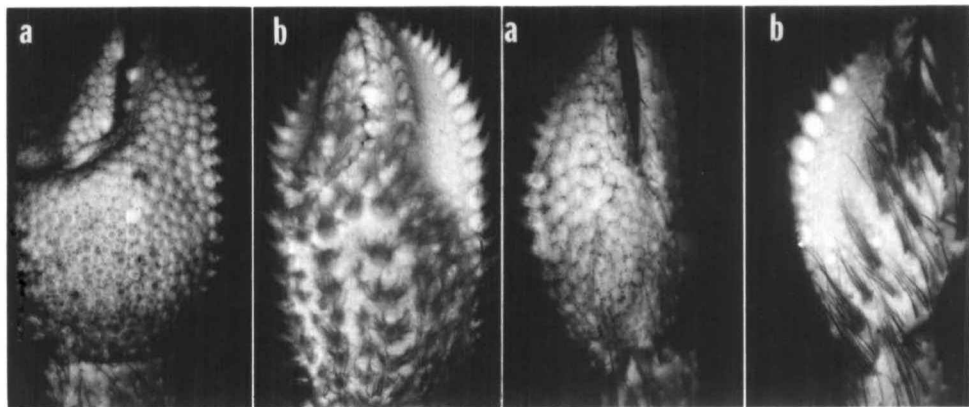


Figure 2. Right chelae: (a) *Rhodochirus rosaceus* (8.7 $\times$ ); (b) *Rhodochirus hirtimanus* (10.0 $\times$ ).

Figure 3. Left chelae: (a) *Rhodochirus rosaceus* (9.9 $\times$ ); (b) *Rhodochirus hirtimanus* (9.9 $\times$ ).

triangular, with strong submarginal spine; separated basally by slightly less than slightly more than basal width of 1 acicle. Right cheliped with ventral margins of merus tuberculate or spinose; carpus with row of strong spines on dorsomesial margin, dorsal surface with long stiff setae or bristles; chela with dorsal surface of palm armed with irregular rows of strong spines and moderately dense, long, stiff setae or bristles, dorsolateral margin with strong spines with basal rosettes, fixed finger with closely-spaced rosettes but generally without accompanying spines except toward cutting edge; dactyl with prominent median ridge of strong spines, dorsolateral surface with closely-spaced rosettes generally without accompanying spines except on dorsomesial margin. Left cheliped with row of strong spines on ventrolateral margin of merus; carpus triangular, with row of strong spines and tufts of long stiff bristles or setae on dorsal margin; chela with row of strong spines on dorsolateral margin and row of smaller spines on dorsal midline, each usually with incomplete basal rosette, fixed finger with closely-spaced rosettes generally without accompanying spines. Dactyls of 2nd and 3rd pairs of pereopods each with rows of corneous spines on dorsal and ventral margins and mesial faces; carpi with 1 or 2 spines ( $P_2$ ) or 1 spine ( $P_3$ ) on dorsal margin distally. Sternite of 3rd pereopods with anterior lobe semisubquadrate to semisubcircular; sternites of pereopods 3 to 5 often with capsulate setae. Telson with terminal margins oblique, each armed with 3 or 4 strong acute spines and often also with few to several smaller spines.

*Distribution*.—Southern end of the Gulf of California, Mexico to northern Peru, Cocos Island, Costa Rica and the Galapagos Islands; 36–182 m.

*Remarks*.—As previously indicated (McLaughlin, 1981) a rhizocephalan infected male paralectotype (SL = 5.4 mm) in the collections of the Museum of Comparative Zoology was found to have a gonopod on the left side. The abdomen had been ripped so that it was impossible to determine if a right gonopod also had been developed during life. In addition, 4 unpaired pleopods were present; the 2nd had both rami reduced, the remaining had one ramus well developed and one considerably reduced.

### *Phimochirus* McLaughlin, 1981

*Elassochirus* Benedict, 1892: 1 (in part). Founded as a subgenus of *Eupagurus* Brandt, 1851.

*Pylopagurus*: Barnard, 1950: 453 (in part).—Walton, 1954: 140 (in part).—Forest and De Saint Laurent, 1968: 145 (in part). Not *Pylopagurus* A. Milne Edwards and Bouvier, 1891.

*Phimochirus* McLaughlin, 1981: 4. Type species by original designation: *Eupagurus operculatus* Stimpson. Gender: Masculine.

*Diagnosis*.—Eleven pairs of phyllobranch gills. Ocular acicles subrectangular to acutely triangular, slender, and with small or very small marginal spine; separated basally by basal width or less of 1 acicle. Sternite of 3rd maxillipeds typically unarmed, midline occasionally with slight depression. Third maxillipeds each with well developed crista dentata with 1 to several accessory teeth; merus with or without small spine at dorsodistal margin. Maxillule with internal lobe of endopod moderately well developed and with 1 or 2 stiff bristles terminally; external lobe produced, not recurved.

Right cheliped with chela subovate to subcircular; dorsal surface pitted, smooth or tuberculate; angle of articulation of chela and carpus approximately perpendicular. Left cheliped with chela small, subtriangular in cross-section, but not with strongly developed keel or crest, palm with low ridge proximally; angle of articulation of chela and carpus 10°–25° from perpendicular. Carpus generally trapezoidal in cross-section.

Anterior lobe of sternite of 3rd pereopods semisubovate to semisubcircular. Sternites of pereopods 3 to 5 often with capsulate setae, particularly 5th.

Fourth pereopods with propodal rasp consisting of single row of corneous scales; dactyl moderately short, claw moderately short to long, blunt or curved; preungual process very well developed at base of claw.

Males and females both with paired gonopores; males without sexual tubes.

Abdomen typically flexed. Males without paired pleopods, but with 3 unpaired biramous pleopods with reduced endopods. Females with paired 1st pleopods modified as gonopods, and with 4 unpaired biramous pleopods, 2nd–4th with both rami well developed, 5th with endopod reduced. Uropods asymmetrical. Telson with transverse suture; posterior lobes asymmetrical or subequal, with terminal margins oblique and armed with series of long and short spines.

*Distribution*.—Western Atlantic from North Carolina, U.S.A. (36°N) to Pernambuco, Brazil; Bermuda; northern Gulf of Mexico; Caribbean Sea; Algoa Bay and Cape Seal, South Africa; eastern Pacific from California to Ecuador; Gulf of California; intertidal to 630 m.

*Etymology*.—*Phimochirus* is from the Greek *phimos* meaning that which stops an opening and *cheir* meaning hand, and refers to the operculate right chela which effectively closes the shell orifice.

#### KEY TO THE SPECIES OF *PHIMOCHIRUS*

- 1a. Palm of right chela with dorsal tuberculate median ridge formed by shallow mesial and lateral depressions ..... *P. randalli*
- 1b. Palm of right chela without dorsal tuberculate median ridge formed by shallow mesial and lateral depressions ..... 2
- 2a. Dorsal surface of palm and fixed finger of right chela noticeably pitted ..... *P. liochele*
- 2b. Dorsal surface of palm and fixed finger of right chela not noticeably pitted ..... 3
- 3a. Dorsal surface of dactyl of right chela with median ridge or row of tubercles or spines ..... 4
- 3b. Dorsal surface of dactyl of right chela without median ridge or row of tubercles or spines .. 8
- 4a. Dorsal surface of palm and fixed finger of right chela with strong or moderately strong tubercles, at least distally ..... 5
- 4b. Dorsal surface of palm and fixed finger of right chela smooth, granular or weakly tuberculate ..... 6
- 5a. Exopod of left uropod with dense tuft of long setae ..... *P. californiensis*
- 5b. Exopod of left uropod without dense tuft of long setae ..... *P. holthuisi*
- 6a. Dorsal surface of carpus of right cheliped unarmed ..... *P. leurocarpus* n. sp.
- 6b. Dorsal surface of carpus of right cheliped tuberculate, spinose or spinulose ..... 7
- 7a. Palm of left chela with dorsal midline unarmed or with few spinules or tubercles proximally; Pacific ..... *P. venustus*
- 7b. Palm of left chela with dorsomedial row of small spines or tubercles extending to base of dactyl; Atlantic ..... *P. operculatus*
- 8a. Exopod of left uropod with dense tuft of long setae ..... *P. roseus*
- 8b. Exopod of left uropod without dense tuft of long setae ..... *P. ocellus*

#### *Phimochirus operculatus* (Stimpson, 1859)

Figures 4a, 5a, 7a

*Eupagurus operculatus* Stimpson, 1859: 46, pl. 1, figs. 9, 10 (type locality: Tortugas, Florida); 1862: 92, pl. 1, figs. 9, 10.

*Pagurus operculatus*: Gordan, 1956: 333.—Provenzano, 1959: 397, fig. 14.

*Pylopagurus operculatus*: Provenzano, 1961: 164.—Hazlett and Provenzano, 1965: 621.—Hazlett, 1966: 86.—Sanchez, 1978: 222, fig. 5A.

*Pylopagurus samariensis* Sanchez, 1978: 215, figs. 1–4, 5C (type locality: Santa Marta, Colombia).

*Phimochirus operculatus*: McLaughlin, 1981: 4 (by implication).

Not *Pylopagurus operculatus*: Holthuis, 1959: 157, fig. 31 (= *P. holthuisi*).

*Holotype*.—Presumably no longer extant.



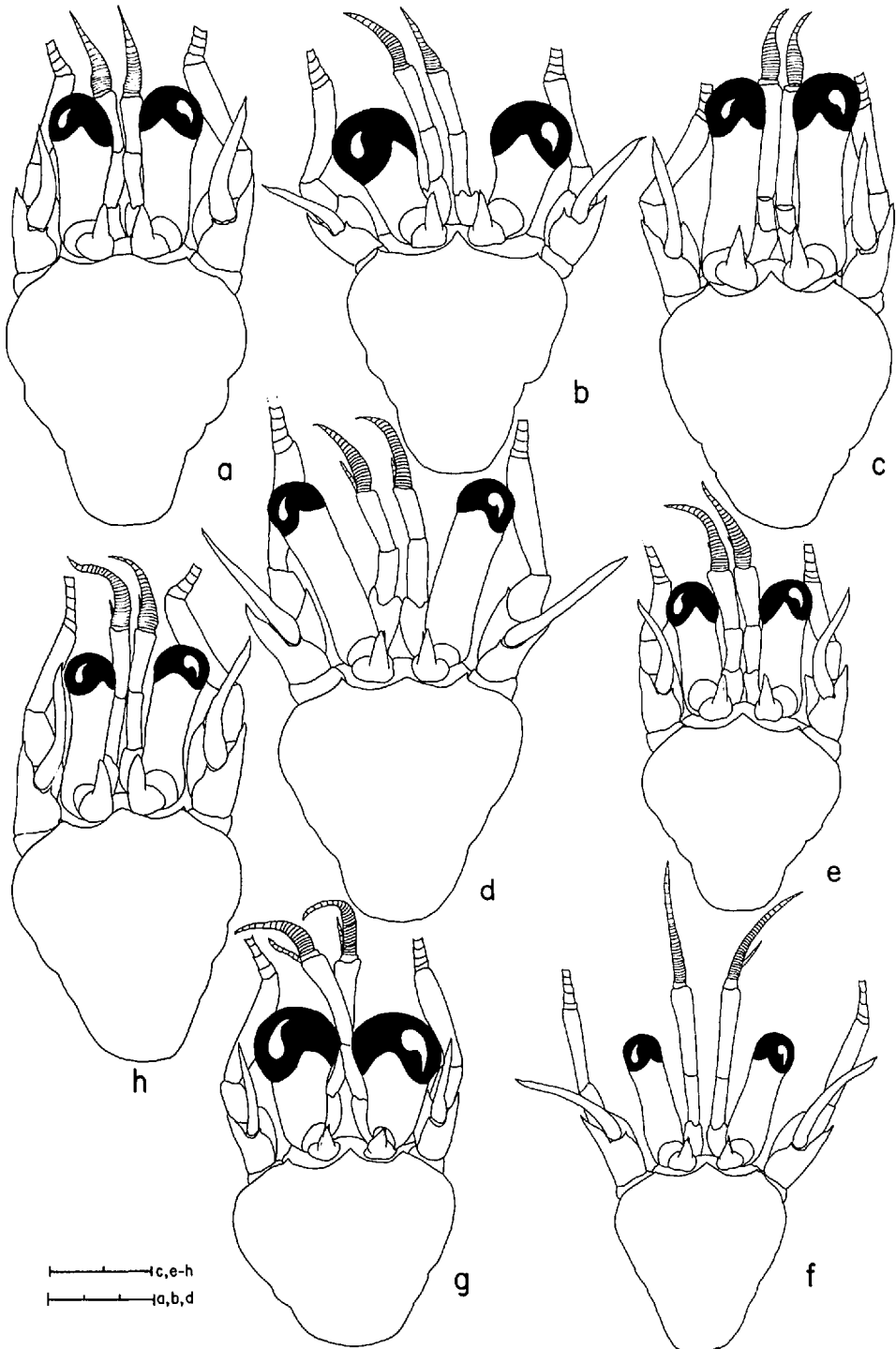


Figure 4. Diagrammatic shield and cephalic appendages: (a) *Phimochirus operculatus*; (b) *Phimochirus randalli*; (c) *Phimochirus holthuisi*; (d) *Phimochirus californiensis*; (e) *Phimochirus venustus*; (f) *Phimochirus leurocarpus* n. sp.; (g) *Phimochirus ocellus*; (h) *Phimochirus roseus*. Scales equal 3 mm (a, b, d) and 2 mm (c, e-h).

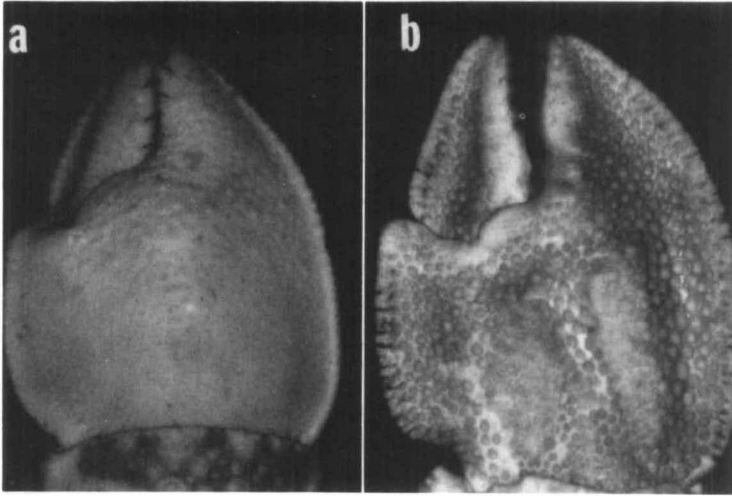


Figure 5. Right chelae: (a) *Phimochirus operculatus* (8.5 $\times$ ); (b) *Phimochirus randalli* (9.1 $\times$ ).

*Material Examined.*—See Table 3.

**Diagnosis.**—Shield usually longer than broad; rostrum triangular or broadly rounded, usually without terminal spine; lateral projections broadly triangular and with small submarginal spine. Ocular peduncles moderately short and stout, with corneae slightly dilated; ocular acicles elongate, acutely triangular and with small submarginal spine; separated basally by approximately two-thirds basal width of 1 acicle. Right cheliped with merus armed with 1–4 spines on dorsodistal margin; carpus with row of strong spines on dorsomesial margin, dorsolateral margin upturned, dorsal surface tuberculate; chela dorsoventrally compressed, operculate, dorsal surface granular or weakly tuberculate; dactyl with median row of low tubercles. Left cheliped with ventrolateral margin of merus armed with row of strong spines; carpus with dorsomesial and shorter dorsolateral row of spines; chela elevated in midline and armed with median row of small spines, extending to dactyl. Dactyls of 2nd and 3rd pereopods equal to or appreciably

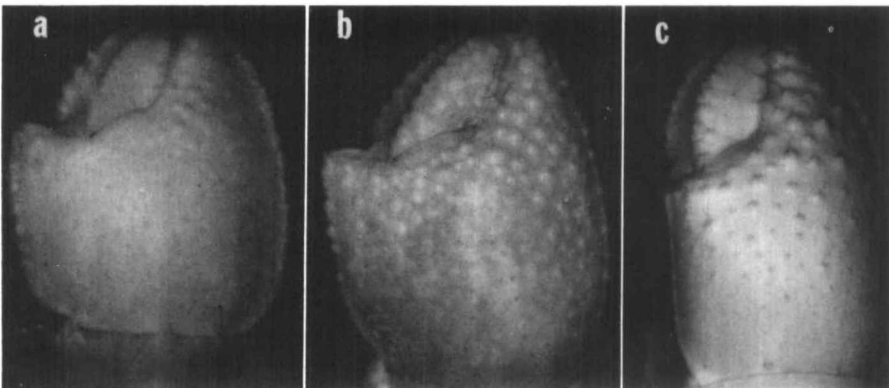


Figure 6. Right chelae: a–c *Phimochirus holthuisi*, (a) 15.6 $\times$ ; (b) 11.4 $\times$ ; (c) 14.5 $\times$ .

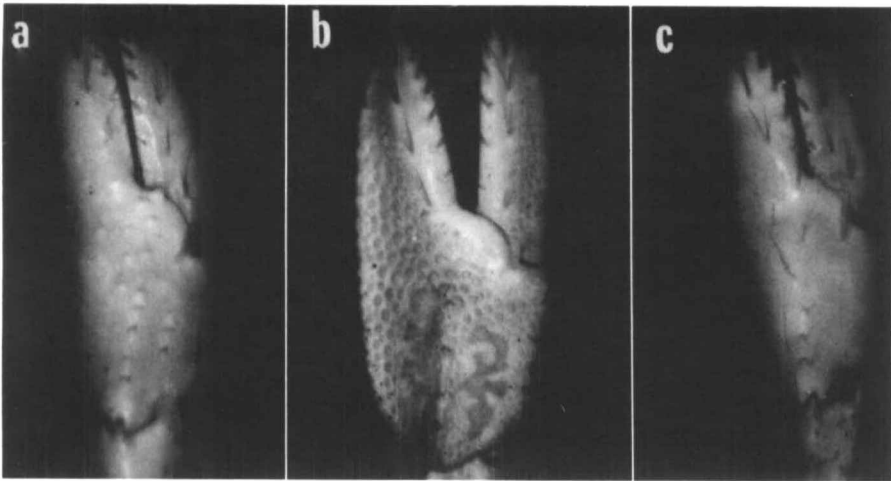


Figure 7. Left chelae: (a) *Phimochirus operculatus* (17.1 $\times$ ); (b) *Phimochirus randalli* (18.8 $\times$ ); (c) *Phimochirus holthuisi* (19.8 $\times$ ).

shorter than propodi, ventral margins of all 4 segments armed with strong corneous spines; carpi each with spine at dorsodistal margin, large specimens occasionally with additional dorsal spines posteriorly. Sternite of 3rd pereopods semiovate to semisubcircular. Telson with terminal margins oblique or occasionally almost straight, each armed with several strong slender spines, frequently interspersed with smaller spines.

Table 3. *Phimochirus operculatus* (Stimpson) Material examined

Locality	Depth (m)	Station Deposition	Date	Sex		SL (mm)	Collector
				♂	♀		
Florida							
—	—	WAS-212 UMML 32:4886	—		1	6.0	—
Miami	—	— FIU	—		1	7.0	—
Miami, Bear Cut	—	— AHF	3/2/67		1	5.9	R. Daly
Miami, off Bear Cut	—	— UMML 32:4890	7/64	1	1	6.2, 5.6	B. Hazlett
Margot Fish Shoal	2	— UMML 32:4889	29/6/67		1	6.3	R. Work
Curaçao							
Off Portomaribrai	15	JCM D-152 AHF	15/4/74		1	5.5	J. Markham
Piscadera Bay	—	— USNM	28/12/62		1	4.4	J. Randall
Colombia							
Santa Marta	—	— FIU, USNM	—/75	1	4	2.7–3.3	H. Sanchez

*Distribution*.—South Florida, Curaçao, Colombia; intertidal to 15 m.

*Remarks*.—In his report on the shallow-water hermit crabs of Florida, Provenzano (1959) remarked that of the 14 specimens in the collections of the National Museum of Natural History identified as *Pylopagurus operculatus* (as *Pagurus*), he had found only one that agreed with his Florida specimens and with Stimpson's (1859) description. Subsequently Provenzano (1961) described a new species, *Pylopagurus holthuisi* from the Virgin Islands and included specimens from Surinam that Holthuis (1959) had questionably assigned to *P. operculatus*. In the interim, Wass (Ms) examined the same Museum specimens and concluded that they represented a species distinct from *P. operculatus*; however, he did not publish his findings. In the course of the present study, I have examined Provenzano's holotype of *P. holthuisi*, the Museum specimens in question, and a large series from Florida, the Gulf of Mexico, western Atlantic and Caribbean. Although *P. holthuisi* is a far more variable species than Provenzano had realized, and the characters he proposed to distinguish this species from *P. operculatus* are not entirely reliable, there can be no doubt that the two are distinct species. The Museum specimens in question are assignable to *Phimochirus holthuisi*.

Sanchez (1978) described *Pylopagurus samariensis* from Colombia, distinguishing it from *P. operculatus* on several minor structural characters and color patterns. After reexamining specimens from Sanchez's Colombian collections sent to me previously, I can find no differences between his species and *P. operculatus*, other than the typical variations expected in species of *Phimochirus*. Therefore, I must conclude that *P. samariensis* is a junior synonym of *P. operculatus*.

*Phimochirus randalli* (Provenzano, 1961)

Figures 4b, 5b, 7b

*Pylopagurus randalli* Provenzano, 1961: 159, fig. 2 (type locality: ridge 5 miles southeast of Lameshur Bay, St. John, Virgin Islands).

*Phimochirus randalli*: McLaughlin, 1981: 5 (by implication).

*Holotype*.—♂ (SL = 6.2 mm) USNM 106353.

*Material Examined*.—See Table 4.

*Diagnosis*.—Shield longer than broad; rostrum prominent, acutely triangular, with very small terminal spine; lateral projections obsolete or broadly triangular, usually with minute terminal spine. Ocular peduncles very short, stout, with corneae strongly dilated; ocular acicles elongate, acutely triangular, usually with small submarginal spine, separated basally by basal width of 1 acicle. Right cheliped with small spines or spinulose tubercles on ventromesial and ventrolateral surfaces and dorsodistal margin of merus; carpus with granules or low tubercles on dorsal, lateral and mesial surfaces, dorsomesial margin with row of irregular spines; chela with dorsal surface of palm and fixed finger covered with relatively regularly spaced, low, flattened tubercles except near proximal midline where 2 longitudinal, rectangular, slightly depressed, granular patches are separated by broad tuberculate ridge; dactyl without raised median row of tubercles or spines. Left cheliped with ventromesial and ventrolateral margins of merus each armed with row of moderately strong to strong spines; carpus with dorsolateral and dorsomesial margins each with irregular row of spines; chela elevated in midline and armed with few low spines or spinules, dorsal surfaces of palm, fixed finger and dactyl with low, usually flattened tubercles. Dactyls of 2nd and 3rd pereopods moderately short, ventral margins each with row of corneous spines; propodi

Table 4. *Phimochirus randalli* (Provenzano) Material examined

Locality	Depth (m)	Station Deposition	Date	Sex		SL (mm)	Collector
				♂	♀		
Straits of Florida 24°59'00"N 80°23'00"W	38	Gerda 599 USNM	4/15/65	1		4.1	RSMAS
Western Atlantic and Caribbean 24°14'24"N 77°36'36"W	15	JCM D-81 USNM	9/6/73	1		1.8	J. Markham
24°14'24"N 77°36'36"W	16	JCM D-85 AHF	9/7/73	1		3.4	J. Markham
23°35'00"N 79°01'00"W	55	Gerda 821 UMML	6/22/67	1		3.7	RSMAS
22°40'00"N 74°18'00"W	18	JCM D-60 AHF	8/27/73		1	3.6	J. Markham
21°50'30"N 72°20'32"W	20	JCM D-69 FIU	8/31/69	1		6.6	J. Markham
SE Lameshur Bay, St. John, V.I.	20	— USNM 106353	2/5/60		1	6.2	J. Randall
21°05'00"N 86°28'00"W	36	Gerda 887 UMML	9/9/67	1		5.0	RSMAS
20°08'00"N 68°52'00"W	26-30	Oregon 5473 UMML	6/12/65	1		4.6	NMFS
18°36'30"N 63°27'00"W	30	Oregon 6716 UMML	5/30/67	1	1	4.6, 6.4	NMFS
15°37'00"N 63°38'00"W	64-91	Oregon 4991 UMML	9/7/64	2		4.3, 6.0	NMFS
S. end Bonaire	16	JCM D-136 FIU	4/10/74		1	5.6	J. Markham

with dorsal surfaces spinulose or tuberculate, ventral margins with corneous spines; carpi each with prominent spine at dorsodistal margin, dorsal surfaces usually spinulose or tuberculate. Sternite of 3rd pereopods with anterior lobe subquadrate to semicircular; sternites of pereopods 3 to 5 frequently with capsulate setae. Telson with terminal margins relatively straight, each armed with several elongate spines interspersed with shorter spines.

*Distribution*.—Bahama Islands; Straits of Florida, eastern and western Caribbean; 15–91 m.

*Remarks*.—The very distinctive pattern of the armature of the right chela of *P. randalli* distinguishes it from all other species of *Phimochirus*.

*Phimochirus holthuisi* (Provenzano, 1961)

Figures 4c, 6a–c, 7c

*Pylopagurus operculatus*: Holthuis, 1959: 157, fig. 31 [not *Pylopagurus operculatus* (Stimpson, 1859)].

*Pylopagurus holthuisi* Provenzano, 1961: 162, fig. 3 (type locality: 4.5 miles southeast of Ram's Head, St. John, Virgin Islands).—Sanchez, 1978: 222, fig. 5B.

*Phimochirus holthuisi*: McLaughlin, 1981: 5 (by implication).

*Holotype*.—♂ (SL = 4.2 mm) USNM 107155.

*Material Examined*.—See Table 5.

*Diagnosis*.—Shield longer than broad; rostrum triangular or rounded, sometimes with minute terminal spinule; lateral projections broadly triangular and with small marginal or submarginal spine. Ocular peduncles moderately short, with corneae slightly dilated; ocular acicles moderately long, acutely triangular and with small submarginal spine, separated basally by slightly less than basal width of 1 acicle. Right cheliped with ventral margins of merus tuberculate, spinulose or spinose, ventrolateral distal angle often with acute spine; carpus with dorsal surface usually slightly tuberculate; chela with dorsomesial angle of palm produced or not, dorsal surface of fixed finger and palm, particularly distally tuberculate, often strongly so, dactyl with dorsal median row of tubercles. Left cheliped with ventrolateral margin of merus armed with 1 spine and usually few spinules; carpus with prominent spine on dorsolateral margin distally and sometimes with additional smaller spines proximally; chela triangular in cross-section, elevated in midline and unarmed or with 2–4 small spines or spinules proximally. Dactyls of 2nd and 3rd pereopods, particularly 3rd, longer than propodi, dorsal and ventral margins usually with strong spiniform, corneous bristles, mesial faces each with 2 rows of corneous spines; carpi each with 1 spine at dorsodistal margin. Sternite of 3rd pereopods with anterior lobe semisubovate to semisubcircular, occasionally subquadrate. Sternites of pereopods 3–5 sometimes with capsulate setae, particularly in males. Telson with terminal margins oblique, each armed with several strong spines interspersed with smaller spines, frequently extending onto lateral margin.

*Distribution*.—Eastern coast of United States from North Carolina to Florida; Bahama Islands, Straits of Florida and Gulf of Mexico from Florida to Texas; Caribbean and northern coast of South America from Colombia to Guiana, Brazil; 1 to 210 m.

*Remarks*.—Provenzano's (1961) description of *P. holthuisi* was based on only a few specimens from the Caribbean and Surinam. He differentiated *P. holthuisi*

Table 5. *Phimochirus holthuisi* (Provenzano) Material examined

Locality	Depth (m)	Station Deposition	Date	Sex		SL (mm)	Collector
				♂	♀		
Western Atlantic							
36°00'24"N 75°10'36"W	32	Eastward 96 UW	10/22/77		1	2.9	G. Herbst
Cape Lookout, N.C.	91	— USNM	10/63		1	2.7	M. Cerame-Vivas
34°54'00"N 75°32'00"W	51	Silver Bay 2926 USNM	3/13/61	1		4.2	NMFS
34°43'N 75°53'W	73	Silver Bay 2933 AHF	3/14/61		1	3.7	NMFS
34°38'30"N 76°06'00"W	36	Eastward 06 UW	10/17/77		1	3.1	G. Herbst
33°32'N 77°32'W	33	Silver Bay 3332 UMML 32.4887	8/14/61	1		5.4	NMFS
32°17'N 79°06'W	73	Combat 165 AHF	10/1/56	1		4.7	NMFS
31°26'32"N 79°42'13"W	252-291	298 USNM 150224	—	3	2	1.6-2.4	
30°51'N 79°58'W	209	— USNM 150226	—	2		2.1, 2.2	
30°05'00"N 80°18'00"W	61	EJ 73-213 DNR	4/22/74		1	3.5	DNR
30°00'N 79°58'W	98-119	— USNM 150225	—	1	2	2.5-3.2	
29°32'12"N 80°14'00"W	73	EJ 74-169 DNR	3/12/74	1		4.4	DNR
28°40'N 80°16'W	35	Oregon II 21868 FIU	4/5/77	2		2.9, 3.4	NMFS

Table 5. Continued

Locality	Depth (m)	Station Deposition	Date	Sex		SL (mm)	Collector
				♂	♀		
28°38'54"N 80°17'48"W	29	Oregon II 21867 FIU	4/5/77	1		3.0	NMFS
28°32'30"N 80°10'18"W	40	EJ 73-125 DNR	7/17/74	2	2	2.3-3.2	DNR
28°25'30"N 80°07'12"W	53	Oregon II 21901 FIU	4/7/77		1	4.0	NMFS
28°24'12"N 80°05'18"W	53	Oregon II 21891 NMFS	4/7/77	1	1	2.6, 3.2	NMFS
28°24'00"N 80°05'42"W	51	Oregon II 21893 FIU	4/7/77	1		4.1	NMFS
28°23'42"N 80°08'00"W	51	Oregon II 21862 AHF	4/4/77		1	2.5	NMFS
28°17'N 80°1"W	62-75	Silver Bay 2010 USNM 119890	4/25/60	2		2.8, 3.2	NMFS
28°14'30"N 80°13'30"W	35	Oregon II 21851 USNM	4/2/77		3	4.4-4.9	NMFS
28°13'N 80°02'W	58-73	Silver Bay 2008 USNM	4/25/60		1	3.0	NMFS
28°03'00"N 80°00'30"W	73	Silver Bay 3279 UMML 32:4888	7/14/61		1	3.7	NMFS
27°55'N 80°07'W	35-38	Silver Bay 5096 USNM	9/26/63		1	3.6	NMFS
27°52'06"N 80°01'06"W	57	Oregon II 21835 FIU	4/1/77		1	4.5	NMFS
27°50'00"N 79°58'8"W	70-80	Gosnold 262/785 SIFPB	8/13/75	1		4.2	SIFPB
27°47'06"N 80°08'36"W	25	Gosnold 237/514 SIFPB	6/12/74		1	3.5	SIFPB



Table 5. Continued

Locality	Depth (m)	Station Deposition	Date	Sex		SL (mm)	Collector
				♂	♀		
27°40'30"N 79°59'06"W	74	Gosnold 245/694 SIFPB	8/28/74		1	4.1	SIFPB
Off Pompano Beach, FL	—	— FIU	5/23/49		1	3.8	—
25°13'N 80°10'W	88–108	Gerda 767 UMML	1/26/66	2		3.1, 3.5	RSMAS
25°01'N 80°19'W	82–84	Silver Bay 2369 AHF	10/25/60	1		4.0	NMFS
24°49'N 80°39'W	42	Gerda 753 USNM	9/15/65	1		3.4	RSMAS
24°29'30"N 81°39'30"W	1–5	RSP 222 DNR	9/25/74	1		3.2	DNR
24°15'30"N 77°37'18"W	18	JCM D-90 FIU	9/8/73		1	2.4	J. Markham
Gulf of Mexico and Straits of Florida							
29°56'00"N 86°06'30"W	38	DC-41-34 DISL	6/3/74	4	2	2.0–2.9	DISL
29°55'59"N 86°06'29"W	37	2529 DISL	9/6/77	4	5	2.0–3.9	DISL
29°55'59"N 86°06'29"W	38	2529 DISL	10/31/77	12	10	2.2–4.3	DISL
29°55'55"N 86°06'29"W	40	2529 DISL	2/8/78	3	2	2.9–4.6	DISL
29°55'42"N 86°06'30"W	40	2529 DISL	6/28/76	2	1	2.1–2.3	DISL
29°51'00"N 86°06'30"W	39	DC-41-35 DISL	6/4/74	1		4.6	DISL
29°48'00"N 86°03'30"W	40	DC-41-37 DISL	6/4/74	6	6	1.5–3.6	DISL

Table 5. Continued

Locality	Depth (m)	Station Deposition	Date	Sex		SL (mm)	Collector
				♂	♀		
29°47'30"N 85°54'30"W	35	DC-41-41 DISL	6/6/74	1		3.3	DISL
29°45'29"N 87°46'24"W	38	2641 DISL	9/6/77	2	1	1.4-3.1	DISL
28°32'16"N 84°18'45"W	30-32	11-23-151 DISL	75-76	1		4.2	DISL
28°29'46"N 84°20'49"W	42	0005 DISL	2/5/78		2	3.8, 3.9	DISL
28°29'45"N 84°19'30"W	35	15-23-III A DISL	75-76		1	3.6	DISL
28°29'43"N 84°20'29"W	42	0005 DISL	7/13/76	1		3.8	DISL
28°28'51"N 84°20'38"W	45	0005 DISL	10/29/77	1		3.6	DISL
28°26'03"N 84°56'02"W	90	0003 DISL	10/29/77	1		3.7	DISL
28°21'00"N 84°24'00"W	50	DC-41-45 DISL	6/18/74	4		2.1-2.3	DISL
28°18'N 94°47'W	46	Oregon 2981 RMNH	10/8/60		1	3.7	NMFS
28°17'N 94°38'W	46	— FIU	—		2	3.1, 4.1	—
27°52'33"N 83°33'55"W	33	2209 DISL	2/4/78		1	4.2	DISL
27°52'32"N 83°34'04"W	35	2209 DISL	10/27/77		5	2.5-4.6	DISL
27°52'22"N 83°23'36"W	30	2749 DISL	4/20/78		2	2.8, 3.7	DISL

Table 5. Continued

Locality	Depth (m)	Station Deposition	Date	Sex		SL (mm)	Collector
				♂	♀		
27°51'56"N 83°27'10"W	33	2209 DISL	7/13/76	2	3	2.6-4.4	DISL
27°50'00"N 83°31'00"W	35	DC-41-62 DISL	6/16/74		1	3.7	DISL
27°45'30"N 83°25'30"W	30	DC-41-65 DISL	6/15/74	1	1	3.4, 3.9	DISL
27°40'18"N 83°53'26"W	53	2748 DISL	8/23/77	4	4	1.8-3.9	DISL
27°37'06"N 83°53'23"W	51	2748 DISL	10/26/77		1	3.6	DISL
27°37'06"N 83°53'31"W	52	2748 DISL	2/4/78	1		2.4	DISL
27°37'00"N 83°54'00"W	52	2748 DISL	7/13/76	5	1	2.0-3.8	DISL
26°25'01"N 82°58'00"W	39	2103 DISL	2/1/78	4		3.8-4.4	DISL
26°05'01"N 82°57'59"W	38	2103 DISL	8/22/77	2	1	2.8-4.3	DISL
26°05'01"N 82°57'59"W	38	2103 DISL	10/23/77	1	1	2.8, 3.8	DISL
26°24'55"N 82°57'56"W	37	2103 DISL	8/22/77	1	1	2.1, 2.6	DISL
26°24'N 82°28'W	18	— AHF	11/14/67	1		4.5	A. Provenzano, Jr.
26°24'N 82°58'W	37	— AHF	11/14/67		1	5.2	A. Provenzano, Jr.
25°59'00"N 82°17'30"W	18-22	Oregon 2448 FIU	3/14/59	1		3.9	NMFS
27°25'N 83°20'W	35	EJ 64-4B DNR	12/22/64	1		4.5	DNR

Table 5. Continued

Locality	Depth (m)	Station Deposition	Date	Sex		SL (mm)	Collector
				♂	♀		
24°26'N 82°58'W	65	Gerda 565 RSMAS	4/12/65	1		3.7	RSMAS
24°21'30"N 82°26'42"W	—	Gerda 1086 USNM	4/26/69		1	3.3	RSMAS
24°18'30"N 82°20'00"W	196-210	Gerda 1083 USNM	4/26/69	1		1.5	RSMAS
Caribbean and Southwestern Atlantic							
21°32'N 86°40'W	—	EJ X-25 DNR	6/18/63	1		5.0	DNR
12°13'N 72°25'W	68	Oregon 5699 USNM	10/12/65		1	2.1	NMFS
11°39'00"N 73°08'30"W	18-27	Pillsbury 780 UMML	7/30/68		1	2.4	RSMAS
11°03'N 74°26'W	18	Oregon 4861 MCZ	5/20/64	1	1	3.6, 4.7	NMFS
10°44'N 66°07'W	60-73	Pillsbury 737 MCZ	7/22/68		1	2.4	RSMAS
09°45'06"N 76°09'06"W	76	Pillsbury 392 UMML	7/16/66	5	3	1.9-3.9	RSMAS
09°45'00"N 76°12'00"W	81-100	Pillsbury 372 RMNH	7/13/66	1		4.0	RSMAS
09°32'06"N 78°33'30"W	53-58	Pillsbury 421 USNM	7/19/66	1		1.9	RSMAS
09°31'18"N 76°15'24"W	57	Pillsbury 365 USNM	7/13/66		1	3.0	RSMAS
07°19'N 56°51'W	55-58	Pillsbury 684 FIU	7/14/68	1		3.6	RSMAS
06°07'N 52°19'W	84-91	Pillsbury 650 USNM	7/8/68	6	8	2.2-3.1	RSMAS

from the closely related *P. operculatus* by the sharpness of the angle at the base of the right major dactyl, the armature of the dorsal surfaces of the right chela and dactyl, the length relationships of the dactyls and propodi of the ambulatory legs and the animals' color patterns. In the course of the current study it has been possible to examine a very large number of specimens of *P. holthuisi* from a number of geographic areas. With the exception of the length relationships of the dactyls and propodi of the 3rd pereopods (dactyls consistently shorter), none of the other reported morphological differences have been found to be constant. *P. holthuisi* appears to be extremely variable both in gross morphology and in pigmentation, and these variations do not appear to be correlated with either locality or depth. Although most moderate to large specimens of this species have prominent tubercles on the dorsal surface of the fixed finger and palm distally, the armature of small specimens tends to grade toward the condition described for *P. operculatus*. The angle at the base of the palm adjacent to the major dactyl is extremely variable; not only does it vary from acute to rounded, but from prominently produced to virtually obsolete (Fig. 6a–c). The angular relationship of the major dactyl to the fixed finger also is quite variable. Although the color pattern of the right cheliped has not, in preserved specimens, approached that described for and observed in specimens of *P. operculatus*, the 2nd and 3rd pereopods of *P. holthuisi* have been observed with both stripes and spots and patterns intermediate between the two.

The most consistent characters that can be used to differentiate *P. holthuisi* from *P. operculatus* are afforded by the left cheliped. In the former species the elevated middorsal region of the palm is unarmed or armed with only a few small spinules or tubercles proximally. In *P. operculatus* this middorsal elevation is armed with a row of small spines or spinules extending to the distal margin adjoining the dactyl. The ventrolateral margin of the merus in *P. holthuisi* is provided with 1 strong spine and a few smaller spines or spinules; whereas this margin in *P. operculatus* is armed with a row of strong spines.

*Phimochirus californiensis* (Benedict, 1892)

Figures 4d, 8a–c, 13a

*Eupagurus californiensis* Benedict, 1892: 21 (type locality: California, herein restricted by lectotype selection to Catalina Harbor, Santa Catalina Island, California).—Faxon, 1895: 55, pl. 11, figs. 2–2f.

*Eupagurus mexicanus* Benedict, 1892: 22 (type locality: Gulf of California, herein restricted by lectotype selection to southern Gulf of California, ALBATROSS station 2825).

*Pagurus californiensis*: Holmes, 1900: 149.—Schmitt, 1921: 143, fig. 93.—Boone, 1932: 9, fig. 3.—Glassell, 1937: 257.

*Pylopagurus californiensis*: Haig et al., 1970: 20.

*Phimochirus californiensis*: McLaughlin, 1981: 5 (by implication).

**Lectotype.**—♂ (SL = 4.4 mm) USNM 16927.

**Material Examined.**—See Table 6.

**Diagnosis.**—Shield longer than broad; rostrum triangular or broadly rounded, usually with small terminal spine; lateral projections broadly triangular, with small submarginal spine. Ocular peduncles moderately long, with corneae dilated; ocular acicles elongate, slender, acutely triangular, with small marginal or submarginal spine, separated basally by basal width or less of 1 acicle. Right cheliped with ventrolateral margin of merus usually armed with 1 or 2 strong spines distally and row of small spines or spinules, sometimes obsolete; carpus with row of strong, usually acute spines on dorsomesial margin, dorsal surface weakly tu-

Table 6. *Phimochirus californiensis* (Benedict) Material examined

Locality	Depth (m)	Station Deposition	Date	Sex		SL (mm)	Collector
				♂	♀		
California							
Catalina Harbor	—	— USNM 16927, 108256	—	4		1.9-4.4	W. Dall
Santa Catalina I.	3-12	— AHF	6-7/73	1	1	4.4, 6.5	M. Wicksten
Corona del Mar	littoral	1440-41 AHF	12/18/41	1		5.9	AHF
Santa Cruz I.	6	— AHF	12/13/69	1		3.4	N. Nicholson
Baja California and Gulf of California, Mexico (Pacific)							
Off Guadalupe I.	64-73	Velero IV 1925-49 AHF	12/20/49		1	5.2	AHF
Melpomene Cove, Guadalupe I.	10-11	Velero IV 1919-49 AHF	12/19/49	1		2.8	AHF
3.75 mi. NNW Punta Eugenia	36	Velero IV 1702-49 AHF	3/5/49		2	2.8, 3.4	AHF
0.5 mi. SE Hughes Pt. Santa Maria Bay	9-33	Velero IV 1787-49 AHF	4/4/49	1	3	2.7-3.2	AHF
1 mi. off Entrada Pt. Magdalena Bay	51-62	Velero IV 1965-50 AHF	5/3/50	1		4.8	AHF
Hutchins Bank	46	Velero IV 1957-50 AHF	5/1/50	1		5.8	AHF
S of Isla San Francisco	27	Velero III 514-36 AHF	2/24/36	1		3.5	AHF
Puerto Escondido	48	Velero III 595-36 AHF	3/16/36	1	2	3.0-3.6	AHF
N of Granite Id., Angel de la Guarda I.	104	Velero III 1055-40 AHF	1/28/40		1	2.4	AHF

Table 6. Continued

Locality	Depth (m)	Station Deposition	Date	Sex		SL (mm)	Collector
				♂	♀		
S end Gulf of California	13	Albatross 2825 USNM 16661, 108256	4/30/88	2	2	2.3-4.3	U.S. Coast Survey
S end Gulf of California	—	Albatross 2828 USNM 16662	5/88	1		3.4	U.S. Coast Survey
Costa Rica (Pacific)							
Off S Viradores Ids.	18	Velero III 257-34 AHF	2/25/34	1	3	2.6-3.3	AHF
Isla del Cano pinnacle	40	Searcher 486 AHF	3/18/72		1	4.0	LA Co. Mus., U. Costa Rica
Off Nuez Id., Cocos I.	57-91	Velero III 773-38 AHF	1/13/38	1		5.2	AHF
Panama							
Bahia Honda	27-56	Velero III 249-34 AHF	2/22/34	2	1	3.6-5.2	AHF
Secas Is.	27	Velero III 251-34 AHF	1/22/34		1	3.2	AHF
Secas Is.	22	Velero III 448-35 AHF	2/5/35	2		2.3, 3.0	AHF
Galapagos Islands							
E of S end Albemarle Id.	106-110	Velero III 190-34 AHF	1/26/34	2		6.6, 6.9	AHF
Post Office Bay, Charles Id.	27	Velero III 167-34 AHF	1/19/34	2	3	2.2-3.9	AHF
Post Office Bay, Charles Id.	15-18	Velero III 193-34 AHF	1/27/34	1	2	2.8-4.5	AHF
Darwin Bay, Tower Id.	72-128	Velero III 783-38	1/16/38		1	3.1	AHF
Punta Espinosa, Fernandina	littoral	— AHF	4/27/75		1	2.9	G. Wellington

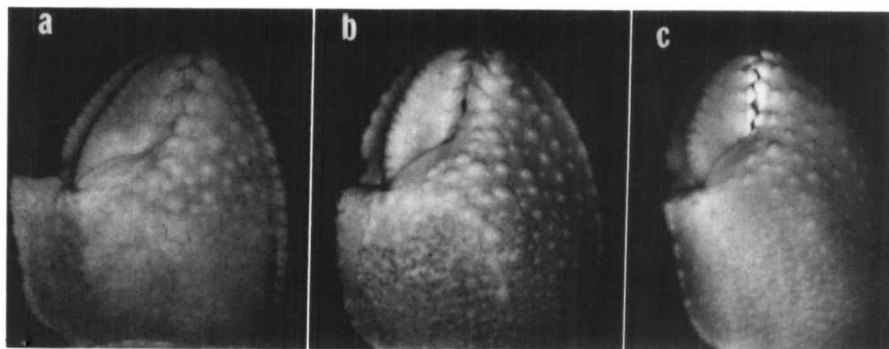


Figure 8. Right chelae: a-c *Phimochirus californiensis*, (a) 7.2 $\times$ ; (b) 11.9 $\times$ ; (c) 15.5 $\times$ .

berculate; palm and fixed finger with dorsal margins usually distinctly elevated, dorsal surface with small to moderately large blunt tubercles at least distally, distomesial angle of palm varying from strongly produced to obsolete (Fig. 8); dactyl with dorsomedial row of tubercles. Left cheliped with 1 or 2 strong spines on ventrolateral margin of merus distally; carpus with 1 to several spines on dorsolateral margin; palm elevated in midline and armed with few small spinules or tubercles proximally. Dactyls and propodi of 2nd and 3rd pereopods each with row of corneous spines on ventral margin; carpi each with 1 spine at dorsodistal margin. Sternite of 3rd pereopods with anterior lobe semisubquadrate to semi-subovate. Sternites of 3rd–5th pereopods often with capsulate setae, at least in males. Exopod of left uropod with tuft of long dense setae. Telson with terminal margins straight or oblique, each armed with several strong spines frequently interspersed with smaller spines.

*Distribution.*—Santa Catalina Island, California to outer coast of Baja California, Mexico and Gulf of California to Ecuador, Cocos and Galapagos Islands; littoral to 129 m.

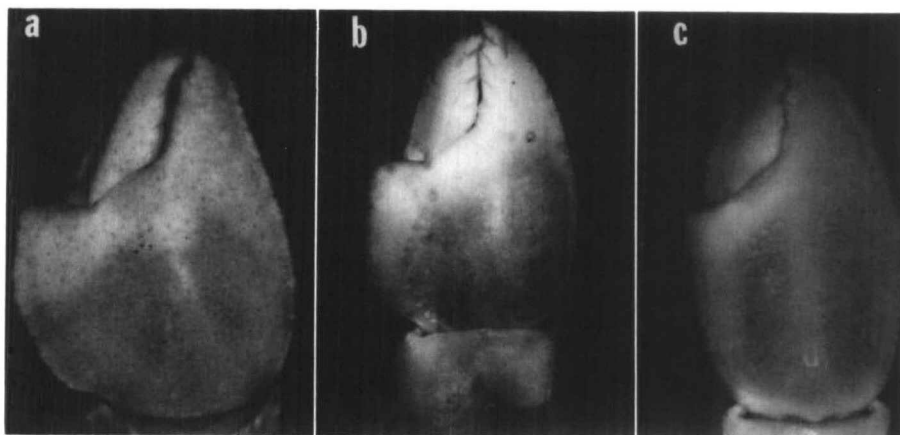


Figure 9. Right chelae: (a) *Phimochirus venustus* (11.9 $\times$ ); (b) *Phimochirus leurocarpus* n. sp. (19.9 $\times$ ); (c) *Phimochirus ocellus* (10.8 $\times$ ).



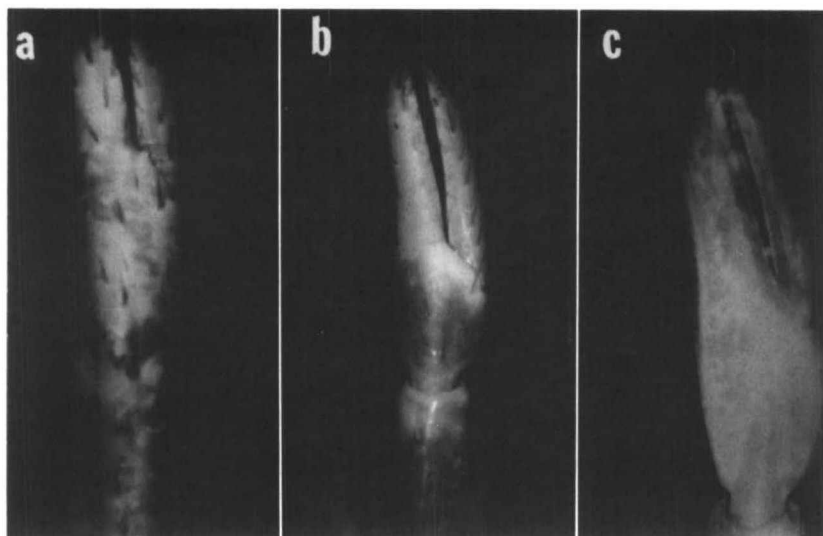


Figure 10. Left chelae: (a) *Phimochirus venustus* (20.0 $\times$ ); (b) *Phimochirus leurocarpus* n. sp. (18.5 $\times$ ); (c) *Phimochirus ocellus* (16.0 $\times$ ).

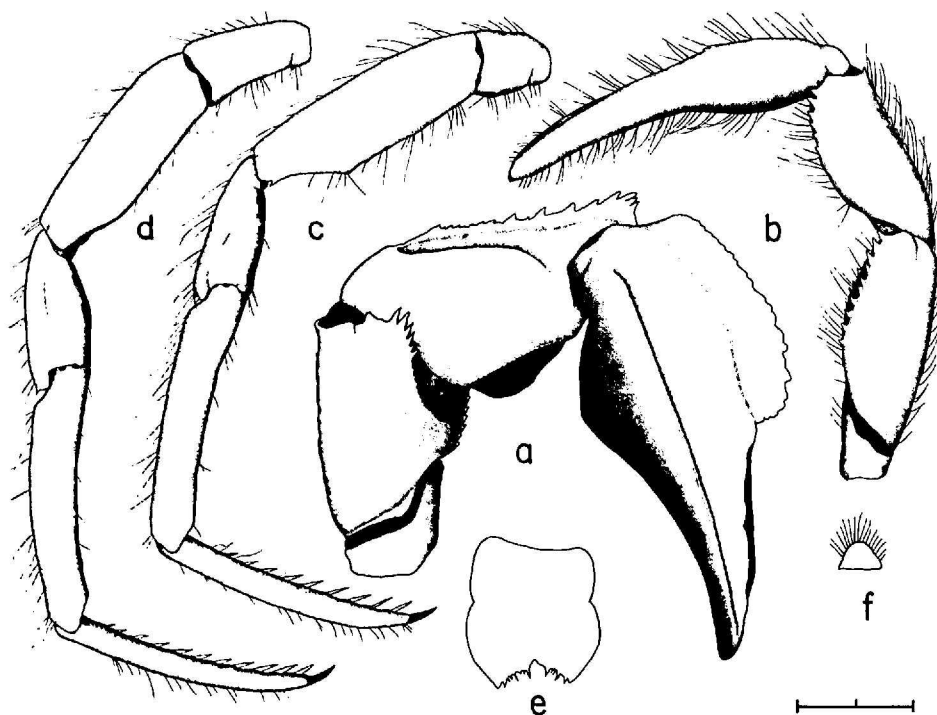


Figure 11. *Phimochirus leurocarpus* n. sp.: (a) right cheliped (lateral view); (b) left cheliped (lateral view); (c) 2nd left pereopod; (d) 3rd left pereopod; (e) telson; (f) sternite of 3rd pereopod, anterior lobe. Scale equals 2 mm (a–d) and 1 mm (e, f).

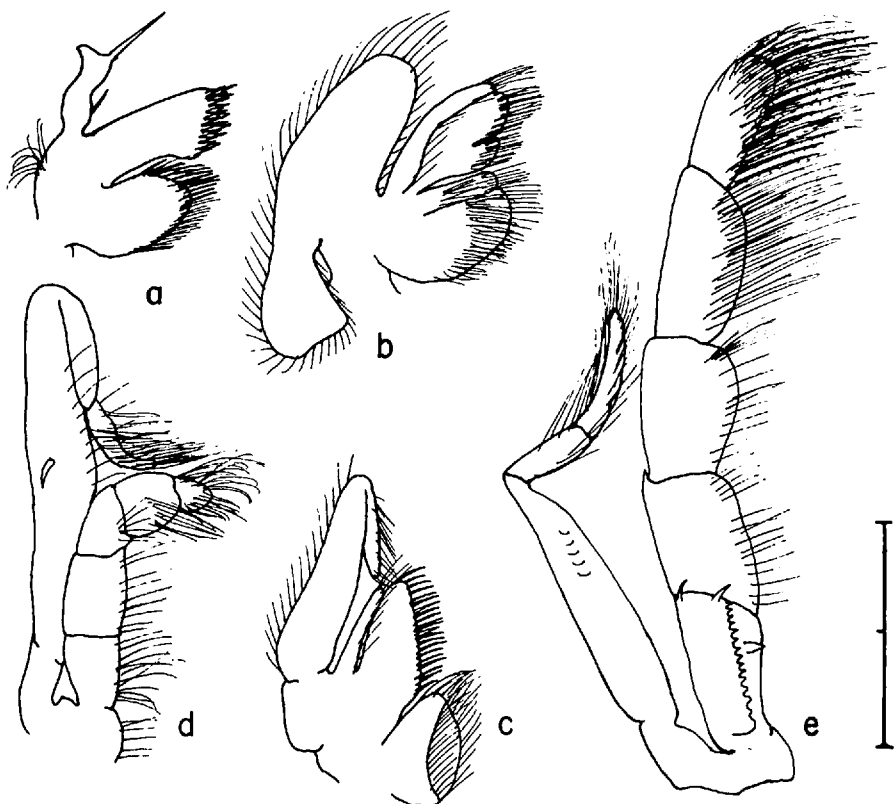


Figure 12. *Phimochirus leurocarpus* n. sp., mouthparts: (a) maxillule; (b) maxilla; (c) 1st maxilliped; (d) 2nd maxilliped; (e) 3rd maxilliped. Scale equals 1 mm.

**Remarks.**—The original descriptions of *P. californiensis* and *P. mexicanus* (Benedict, 1892) were based on four and five specimens respectively. The former species has page priority and has been reported by numerous authors; references to the latter are only the literature citations of Alcock (1905) and Gordan (1956). *P. californiensis*, like its Atlantic counterpart *P. holthuisi*, exhibits a great deal of variability both in the structure and the armature of the right cheliped. After comparing the type series of *P. mexicanus* with a moderately large series of *P. californiensis* from throughout its range, and observing the same broad range of variation in characters present in the Atlantic species, I must conclude that *P. mexicanus* is a junior subjective synonym of *P. californiensis*.

*P. californiensis* appears most closely allied to *P. holthuisi* and it is probable that these species represent a geminate pair. In addition to the general differences in color patterns (cf. Holthuis, 1959; Provenzano, 1961; Haig et al., 1970), *P. californiensis* has developed a dense tuft of stiff setae on the exopod of the left uropod that is not present in *P. holthuisi*.

#### *?Phimochirus liochele* (Barnard, 1947)

*Pylopagurus liochele* Barnard, 1947: 376 (type localities: off Cape Seal and Algoa Bay, South Africa); 1950: 455, fig. 84a–f.

*?Phimochirus liochele*: McLaughlin, 1981: 5 (by implication).

**Type Series.**—♂ (CL = 12 mm), ♀ (CL = 5 mm) South African Museum.

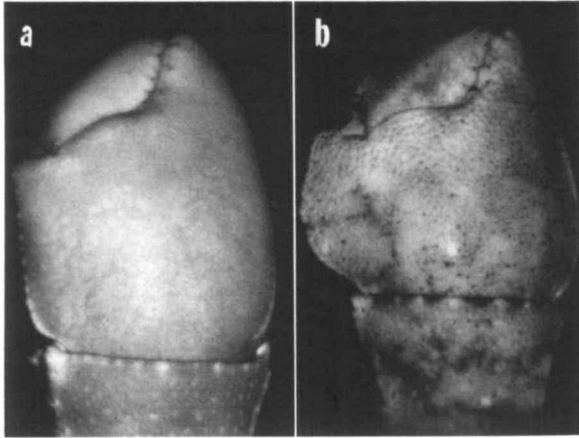


Figure 13. Right chelae: a, b *Phimochirus roseus*, (a) 8.7 $\times$ ; (b) 8.1 $\times$ .

*Material Examined*.—None.

*Diagnosis* (after Barnard, 1950).—Shield as long as broad; rostrum not prominent. Ocular peduncles moderately long, with corneae slightly dilated; ocular acicles acute. Right cheliped with 1 spine at dorsodistal margin of merus; carpus with dorsomesial and dorsolateral margins serrate, dorsal surface with few low granules (or tubercles); chela with dorsal surface of palm and fixed finger pitted, mesial and lateral margins crenulate; dactyl with dorsomedial row of granules (or tubercles). Left cheliped with dorsal surface of palm and fixed finger not elevated in midline. Dactyls of 2nd and 3rd pereopods approximately equal in length to propodi, ventral margins each armed with row of corneous spines. Telson with terminal margins almost straight, each armed with numerous small denticles or spines.

*Distribution*.—Known only from type localities.

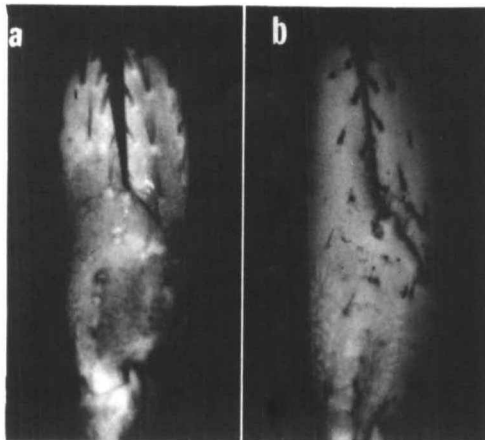


Figure 14. Left chelae: (a) *Phimochirus californiensis* (17.8 $\times$ ); (b) *Phimochirus roseus* (18.0 $\times$ ).

*Remarks.*—On the basis of Barnard's (1950) description and figures, I tentatively have assigned this species to *Phimochirus*; however, confirmation of this assignment must await a more detailed description of this species.

*Phimochirus venustus* (Bouvier, 1898)

Figures 4e, 9a, 10a

*Eupagurus venustus* Bouvier, 1898: 383 (type locality: Bahía de la Paz, Gulf of California).

*Pylopagurus venustus*: Haig et al., 1970: 21.

*Phimochirus venustus*: McLaughlin, 1981: 5 (by implication).

*Holotype.*—♂ (CL = ~12 mm) not seen.

*Material Examined.*—See Table 7.

*Diagnosis.*—Shield approximately as broad as long; rostrum broadly triangular or rounded, usually without terminal spine; lateral projections obtusely triangular or rounded, usually with small submarginal spine. Ocular peduncles moderately short, with corneae slightly dilated; ocular acicles narrow, acutely triangular, with very small submarginal spine; separated basally by slightly less than basal width of 1 acicle. Right cheliped with ventrolateral margin of merus denticulate, 1 spine distally; carpus with spinulose or tuberculate dorsal surface, dorsomesial and dorsolateral margins usually with irregular row of short spines; chela with dorsomesial margin of palm typically produced and armed with irregularly spaced small spines, dorsolateral margin with small spines or low tubercles, dorsal surface unarmed or with a few small tubercles on the fixed finger distally; dactyl with dorsomedian row of low tubercles. Left cheliped with ventrolateral margin of merus armed with row of strong spines; carpus with row of spines on both dorsolateral and dorsomesial margins and with numerous tufts of long setae; palm with dorsomedian proximal elevation unarmed. Dactyls of 2nd and 3rd pereopods usually shorter than or equal to length of propodi, ventral margins each with row of strong corneous spines; dactyls, propodi, carpi and meri all with numerous tufts of short stiff bristles, carpi each with 1 spine near dorsodistal margin. Sternite of 3rd pereopods with anterior lobe semisubovate. Telson with terminal margins oblique, armed with several slender strong spines interspersed with much smaller spines.

*Distribution.*—Outer coast of Baja California, Mexico, Gulf of California, Costa Rica, La Plata I. and Cape San Francisco, Ecuador; 8–20 m.

*Remarks.*—As *P. venustus* is known from relatively few specimens, the range of variation in the structure and armature is not known; however, if this species follows the patterns of other species in the genus, this range would be expected to be considerable. It appears that *P. venustus* is most closely related to the Atlantic *P. leurocarpus* n. sp., but is easily distinguished from that species by the spinulose or tuberculate armature of the dorsal surface of the carpus of the right chela. *P. venustus* is distinguished most easily from other Pacific species of *Phimochirus* by the absence of a dense tuft of setae on the exopod of the left uropod.

*Phimochirus leurocarpus* new species

Figures 4f, 9b, 10b, 11a–f, 12a–e

*Holotype.*—♀ (SL = 2.1 mm) USNM 180382; type locality: PILLSBURY station 736, 10°57'N 65°52'W.

*Material Examined.*—See Table 8.

Table 7. *Phimochirus venusius* (Bouvier) Material examined

Location	Depth (m)	Station Deposition	Date	Sex		SL (mm)	Collector
				♂	♀		
Costa Rica (Pacific)							
Isla Solera, Quepos	17	Searcher 464 AHF	3/12/72	1	3	2.5-3.6	LA Co. Mus., U. Costa Rica
Ecuador							
Cape San Francisco	27	Velero III 850-38 AHF	2/23/38	3		3.1-3.7	AHF
La Plata I.	10	Argosy 76 AHF	10/8/61		1	3.7	RSMAS

Table 8. *Phimochirus leurocarpus* new species Material examined

Locality	Depth (m)	Station Deposition	Date	Sex		SL (mm)=	Collector
				♂	♀		
Bermuda							
2 mi. S Castle Roads	65	— BBS	9/25/76	1		1.4	J. Markham
3 km S Castle Roads	73-110	— BBS	11/12/78		1	1.7	J. Markham
Out from Castle Roads	229	— AHF	9/6/75	1		2.5	J. Lightbourne
Western Atlantic and Caribbean							
24°05'00"N 80°20'00"W	155-219	Gerda 984 USNM, RSMAS, FIU	3/5/68		3	1.8-2.2	RSMAS
18°38'30"N 68°12'00"W	201	Silver Bay 5188 RSMAS	10/17/63	1		3.7	NMFS
10°57'00"N 65°52'00"W	64-155	Pillsbury 736 USNM	7/22/68		1	2.2	RSMAS

*Description.*—Shield longer than broad, anterolateral margins sloping, anterior margin between rostrum and lateral projections straight or concave, posterior margin truncate or slightly rounded; dorsal surface often with few scattered tufts of setae. Rostrum moderately short, triangular, sometimes with small terminal spinule, occasionally rounded. Lateral projections broadly triangular, with small marginal or submarginal spine.

Ocular peduncles moderately long, approximately two-thirds length of shield, with base and cornea slightly dilated, dorsal and mesial faces often with few tufts of setae. Ocular acicles narrowly triangular, elongate, with small acute submarginal spine; separated basally by basal width or less of 1 acicle.

Antennular peduncles moderately long, usually exceeding ocular peduncles by approximately one-half length of ultimate segment. Ultimate and penultimate segments unarmed; basal segment with small spine on ventromesial margin.

Antennal peduncles moderately long, exceeding length of ocular peduncles by approximately one-fourth length of ultimate segment; with supernumerary segmentation. Fifth and fourth segments with few scattered setae. Third segment with small spine at ventrodistal margin. Second segment with dorsolateral distal angle produced, terminating in small acute spine, mesial and lateral margins with few stiff setae; dorsomesial distal angle with small spine, mesial margin with few short setae. First segment with ventral margin produced and with 1 small spine laterally. Antennal acicle elongate, arcuate, with small terminal spine and with tufts of moderately long, stiff setae. Antennal flagella moderately long, with few short setae every 4th or 5th article, increasing in number of articles distally.

Mandible without distinguishing characters. Maxillule (Fig. 12a) with 1 or 2 stiff bristles on moderately well developed internal endopodal lobe, external lobe weakly produced, proximal endite subtriangular. Maxilla (Fig. 12b) with endopod exceeding scaphognathite in distal extension. First maxilliped (Fig. 12c) with basal segment of exopod not protuberant. Second maxilliped with basis-ischium fusion incomplete. Third maxilliped (Fig. 12e) with crista dentata well developed, accessory tooth present; merus with small spine at dorsodistal margin. Sternite of 3rd maxillipeds with minute spinule on either side of midline.

Chelipeds unequal, right stronger although not considerably longer than left. Right cheliped with dactyl equalling or slightly shorter than length of palm; cutting edge with several strong calcareous teeth, terminating in small corneous claw and slightly overlapped by fixed finger; dorsal surface elevated in midline but unarmed, dorsomesial margin serrate or with row of small blunted spines, ventral surface with scattered tufts of setae. Palm moderately long, two-thirds to four-fifths length of carpus, dorsoventrally compressed; dorsomesial margin produced and elevated, often markedly so, and usually armed with row of small, somewhat blunted spines, occasionally obsolete, dorsal surface slightly convex and unarmed, dorsolateral margin weakly spinulose or denticulate distally and extending onto fixed finger proximally; fixed finger with few tufts of setae, cutting edge with row of calcareous teeth and terminating in small corneous claw; ventral surface unarmed but with few scattered tufts of setae. Carpus moderately long, exceeding length of merus; dorsal surface flattened and unarmed, dorsomesial margin elevated and usually armed with row of small to moderately strong spines and tufts of long setae, occasionally only denticulate or tuberculate, dorsolateral margin upturned and unarmed; mesial face deeply excavated, margins slightly upturned, mesial, lateral and ventral surfaces unarmed, but with few scattered tufts of setae. Merus subtriangular; ventromesial margin with row of small to moderately strong spines, ventrolateral margin with one to several acute spines distally and occasionally

additional spinules proximally; dorsodistal margin with few short setae. Ischium unarmed. Coxa with tuft of setae on ventromesial distal angle.

Left cheliped elongate, only slightly shorter than right. Dactyl elongate, slender; dorsal surface elevated in midline and with row of short setae, ventromesial margin with row of setae; cutting edge with row of small corneous teeth, terminating in small corneous claw. Palm elevated in midline and occasionally with few minute spinules extending onto fixed finger proximally, often with 1 acute spine on distal margin adjacent to dactyl; fixed finger elongate, somewhat elevated in midline and with row of tufts of setae, ventrolateral margin occasionally with few minute spinules proximally; cutting edge with row of small calcareous teeth interspersed with small corneous teeth, terminating in small corneous claw. Carpus moderately long, approximately equalling merus in length; dorsomesial and dorsolateral margins often with low protuberances and tufts of setae, usually with 1 spine near distal margin; lateral face with 1 spine and occasionally also few spinules on distal margin ventrally; ventral and mesial faces with tufts of setae. Merus laterally compressed; dorsodistal margin with few setae; ventrolateral margin with row of spines, increasing in size distally, occasionally with only 1 or 2 distal spines; ventromesial margin sometimes with row of small spines, decreasing in size distally. Ischium with row of small spinules on ventral margin. Coxa with tuft of setae on ventromesial distal angle.

Ambulatory legs usually slightly overreaching right cheliped, generally similar from left to right. Dactyls approximately equal to propodi in length; in lateral view slightly curved ventrally, in dorsal view slightly twisted; terminating in strong corneous claws; dorsal surfaces each with row of long setae; ventral margins each with row of long, strong corneous spines; lateral and mesial faces with scattered tufts of setae, mesial faces of 3rd pereopods also with row of corneous spinules dorsally. Propodi moderately long, approximately twice length of carpi; ventral margins each with row of widely spaced, small corneous spines, dorsal surfaces with tufts of moderately long setae. Carpi moderately long, approximately one-half length of meri; dorsal margins each with row of long stiff setae and 1 small spine at distal margin; tuft of stiff setae on ventral margin distally. Meri laterally compressed; dorsal surfaces with tufts of short, rather stiff setae; ventral margins also with tufts of moderately long setae and occasionally 1 small spine on ventrolateral margin distally. Ischia with setae on dorsal and ventral margins. Coxae with long setae on ventromesial margins. Sternite of 3rd pereopods with anterior lobe semisubovate to semisubcircular, terminal margin with long setae.

Exopod of left uropod with row of long stiff bristles on ventral margin. Telson with posterior lobes subequal, separated by shallow but moderately wide median cleft; terminal margins oblique, armed with several small and few moderately large spines.

*Color*.—Eye color of living specimens is yellow. Color patterns observed on a fresh molt suggest that *P. leurocarpus* basically may be translucent with scattered small patches of light orange on the segments of the chelipeds. The lateral faces of the propodi of the ambulatory legs appear to be faintly marked with 2 or 3 longitudinal orange stripes and the carpi and meri with a few small patches of light orange. [These color notes are based on specimens held in the laboratory by Dr. A. J. Provenzano, Jr.]

*Distribution*.—Bermuda, Straits of Florida, Caribbean Sea south of Puerto Rico and north coast of Venezuela; 38–202 m.

Table 9. *Phimochirus ocellus* (Henderson) Material examined

Location	Depth (m)	Station Deposition	Date	Sex		SL (mm)	Collector
				♂	♀		
Caribbean							
18°47'00"N 64°46'42"W	205-380	Pillsbury 991 USNM, RSMAS	7/23/69	1	1	2.7, 3.7	RSMAS
Southwestern Atlantic							
Off Pernambuco, Brazil	640	Challenger 122 BM	—	1		4.0	RSMAS

**Remarks.**—This species bears superficial resemblances to both *P. liochelus* and *P. ocellus*. *P. leurocarpus* may be distinguished from the former species by its unpitted right cheliped and slender, elongate left chela with unarmed dactyl. The rows of strong corneous spines on the ventral margins of the dactyls of the ambulatory legs, together with their unarmed dorsal surfaces of the propodi and single dorsodistal carpal spines, immediately separate this species from *P. ocellus*.

The specific name is derived from the Greek *leuros* meaning even and smooth, and *karpos* meaning carpus, and refers to the smooth level surface of the carpus of the right cheliped.

*Phimochirus ocellus* (Henderson, 1888)

Figures 4g, 9c, 10c

*Eupagurus ocellus* Henderson, 1888: 70, pl. 7, fig. 6 (type locality: off Pernambuco, Brazil, CHALLENGER station 122).

*Pagurus ocellus*: Gordan, 1956: 332.

*Pylopagurus ocellus*: Forest and De Saint Laurent, 1968: 145, figs. 113, 115-119.

*Phimochirus ocellus*: McLaughlin, 1981: 5 (by implication).

**Holotype.**—♂ (SL = 4.0 mm) BM 88:33.

**Material Examined.**—See Table 9.

**Diagnosis.**—Shield as long or slightly longer than broad; rostrum triangular, triangular, sometimes slightly keeled and with subacute spine; lateral projections broadly triangular or slightly rounded, sometimes with small submarginal spine. Ocular peduncles short, corneae strongly dilated; ocular acicles triangular, with moderately strong submarginal spine; separated basally by slightly more than basal width of 1 acicle. Right cheliped with ventral surface and margins of merus spinulose or spinose; carpus with dorsomesial and dorsolateral margins each armed with row of spinules or slender spines, dorsal and ventral surfaces spinulose or granular; palm and dactyl with dorsal surfaces unarmed, dorsomesial and dorsolateral margins crenulate or spinulose, slightly upturned. Left cheliped with ventral margins of merus each with row of small spines or tubercles; carpus with row of strong spines on dorsolateral margin and row of smaller spines on dorsomesial margin, both with tufts of very stiff setae; chela elongate, slender, fixed finger and dactyl ventrally spoon-shaped; palm elevated in midline proximally and armed with very small spinules or denticles, dorsolateral margin minutely spinulose; dactyl unarmed. Dactyls of 2nd and 3rd pereopods elongate, slender, strongly curved, ventral margins each with row of fine setae; dorsal



Table 10. *Phimochirus roseus* (Benedict) Material examined

Locality	Depth (m)	Station Deposition	Date	Sex		SL (mm)	Collector
				♂	♀		
Gulf of California, Sonora							
Punta Cholla	—	— AHF	4/23/40	1	2	4.1–5.2	S. Glassell
Off Adair Bay	—	Albatross 3025 USNM 16660	—	1		4.8	U.S. Coast Survey
Norse Beach	littoral	— USNM 122865	1/20/62		1	5.4	C. Westervelt
Pta. de las Cuevas	littoral	— AHF	2/2/58	1	2	4.7–6.3	E. Reese
Tepoca Bay	littoral	Velero III 1076-40 AHF	2/3/40		1	4.9	AHF
Turner's I.	—	Velero III 1042-40 AHF	1/24/40	1		7.3	AHF
Costa Rica (Pacific)							
N side Bahía Jobo	8	Searcher 398	1/14/72	1		5.4	LA Co. Mus., U. Costa Rica
Bahía Los Huevos	6	Searcher 418 AHF	2/18/72	1		5.3	LA Co. Mus., U. Costa Rica

surfaces of propodi and carpi each armed with small spinules or spines; ventral margins of meri spinulose. Sternite of 3rd pereopods with anterior lobe semisubovate to semisubcircular. Telson with terminal margins very oblique, each armed with 3 or 4 strong spines.

*Distribution*.—Off Virgin Islands and Brazil; 103–640 m.

*Remarks*.—As previously indicated, *P. occlusus* most closely resembles *P. leurocarpus* but easily may be distinguished from that species by the armature of the dorsal surfaces of the propodi and carpi of the ambulatory legs. *P. occlusus* also lacks the rows of spines on the ventral margins of the dactyls of these appendages that are present in *P. leurocarpus*.

*Phimochirus roseus* (Benedict, 1892)

Figures 4h, 13a,b, 14b

*Eupagurus roseus* Benedict, 1892: 22 (type locality: Gulf of California off Adair Bay, Mexico, ALBATROSS station 3025).

*Pagurus roseus*: Gordan, 1956: 335.

*Pylopagurus roseus*: Haig et al., 1970: 21.

*Phimochirus roseus*: McLaughlin, 1981: 5 (by implication).

*Holotype*.—♀ (SL = 4.8 mm) USNM 16660.

*Material Examined*.—See Table 10.

*Diagnosis*.—Shield approximately as long or slightly longer than wide; rostrum triangular or rounded, sometimes produced and with terminal spinule; lateral projections obtusely triangular, with small marginal or submarginal spine. Ocular peduncles moderately short, corneae slightly dilated; ocular acicles elongate, acutely triangular, with very small submarginal spinule; separated basally by less than basal width of 1 acicle. Right cheliped with ventral margins of merus weakly tuberculate or spinulose; carpus with row of spines on dorsomesial margin, dorsolateral margin usually delineated as low ridge, distal margin usually spinulose or tuberculate; palm with dorsomesial distal margin sometimes expanded, armed with row of small spinules, spines or tubercles, dorsal surface usually granular or with small tubercles, occasionally almost smooth; dactyl without median ridge or row of tubercles, dorsomesial margin with row of very small spines or tubercles. Merus of left cheliped with row of acute spines on ventrolateral margin and on ventromesial margins at least proximally. Carpus with dorsolateral and dorsomesial margins each armed with row of spines. Palm elevated in midline and armed with row of small spines extending to base of dactyl. Dactyls of 2nd and 3rd pereopods shorter than or equal to length of propodi, mesial and lateral faces with rows of strong corneous spines; propodi each with ventral row of corneous spines; carpi each with dorsodistal spine. Sternite of 3rd pereopods with anterior lobe semisubovate, sometimes lateral margins denticulate or spinulose. Exopod of left uropod with dense fringe of thick setae. Telson with terminal margins oblique and armed with moderately short to long teeth or spines, interspersed with small denticles or spinules.

*Distribution*.—Outer coast of Baja California and northern Gulf of California, Costa Rica and Ecuador; intertidal to 3 m.

*Remarks*.—Specimens from Costa Rica differ from typical specimens of *P. roseus* in having the dorsomesial margin of the palm of the right chela expanded considerably and in the more tuberculate dorsal surfaces of the chela and carpus. How-

ever, these characters have been found to be subject to considerable intraspecific variation among species of *Phimochirus*. In all diagnostic characters these specimens agree with *P. roseus* from the Gulf of California and Baja. This species is most easily distinguished from *P. californiensis* and *P. venustus* by the presence, in these latter two species, of a dorsomedial tuberculate or spinulose ridge on the dactyl of the right cheliped. In *P. californiensis* the dorsal midline of the left chela is armed with only a few small spinules proximally; whereas a row of small spinules extends to the base of the dactyl in *P. roseus*. The absence of a tuft of stiff setae on the exopod of the left uropod of *P. venustus* also will distinguish that species from *P. roseus*.

#### Interrelationships Among Species of *Phimochirus* and *Rhodochirus*

In general the distribution of species of *Phimochirus* appears to be in agreement with the vicariance model of Caribbean biogeography proposed by Rosen (1976). As might be expected, a larger number of Atlantic species are recognized; however, the basic patterns are equally well represented in the eastern Pacific. Interestingly enough even the distributions of the Pacific species, which include, in addition to the Gulf of California and Central America, the Galapagos Islands and Ecuador, agree with the model.

As previously mentioned, the morphological similarities and degree of intra-specific variation found in *P. holthuisi* (Atlantic) and *P. californiensis* (Pacific) are so striking that the two must be considered geminate species. The similarities between the species pairs *P. operculatus* (Atlantic) and *P. roseus* (Pacific) and *P. leurocarpus* (Atlantic) and *P. venustus* (Pacific) are not as immediately apparent; however, there can be little doubt as to their ancestral relationships. In contrast to some of the porcellanid crabs, in which the Atlantic and Pacific populations are morphologically indistinguishable (Gore and Abele, 1976) *Phimochirus* species all have developed distinct morphological differences. Of the remaining Atlantic species, *P. randalli* appears most closely allied to *P. operculatus*; whereas *P. occlusus* shares a number of morphological features with *P. leurocarpus*. As has been indicated previously, *P. liochele* has been assigned only questionably to *Phimochirus*. The relationship, if any, of this southeast African species to the other members of the genus is not known.

*Rhodochirus* presently has only one western Atlantic and one eastern Pacific representative. While obviously related, there is far greater morphological divergence between these two species than is seen in *Phimochirus*. *R. hirtimanus* has evolved much stronger armature and heavier setation than has *R. rosaceus*. Whether such development is in response to harsher environmental conditions in the Pacific is uncertain.

#### ACKNOWLEDGMENTS

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## LITERATURE CITED

- Alcock, A. 1905. Anomura. Fasc. 1. Pagurides.—Catalogue of the Indian decapod Crustacea in the collection of the Indian Museum. 2: 1–197, Calcutta, Indian Museum.
- Barnard, K. H. 1947. Descriptions of new species of South African Crustacea, with notes on synonymy and new records. *Ann. Mag. Nat. Hist.* (11) 13: 361–392.
- . 1950. Descriptive catalogue of South African decapod Crustacea (crabs and shrimps). *Ann. S. Afr. Mus.* 38: 1–837.
- Benedict, J. E. 1892. Preliminary descriptions of thirty-seven new species of hermit crabs of the genus *Eupagurus* in the U.S. National Museum. *Proc. U.S. Natl. Mus.* 15: 1–26.
- Boone, L. 1932. The littoral fauna of the Galapagos Islands. Part 2. Anomura. *Zoologica*, N.Y. 14: 1–62.
- Bouvier, E. L. 1898. Sur quelques crustacés anomoures et brachyures recueillis par M. Diguët en Basse-Californie. *Bull. Mus. Hist. Nat. Paris.* 4: 371–384.
- Brandt, F. 1851. *Krebse in: A. T. von Middendorff, Reise in den äussersten Norden und Osten Sibiriens während der Jahre 1843 und 1844.* 2 (Zoologie): 77–148.
- Faxon, W. 1893. Reports on the dredging operations off the west coast of Central America to the Galapagos to the west coast of Mexico, and in the Gulf of California . . . Part 6. Preliminary descriptions of new species of Crustacea. *Bull. Mus. Comp. Zool.* 24: 149–220.
- Forest, J., and M. de Saint Laurent. 1968. Campagne de la *Calypso* au large des côtes atlantiques de l'Amérique du Sud (1961–1962). 6. Crustacés Décapodes: Pagurides. *Ann. Inst. Océanogr.*, Monaco 45: 47–169.
- Glassell, S. A. 1937. Hermit crabs from the Gulf of California and the west coast of Lower California. The Templeton Crocker Expedition. *Zoologica*, N.Y. 22: 241–263.
- Gordan, J. 1956. A bibliography of pagurid crabs, exclusive of Alcock, 1905. *Bull. Amer. Mus. Nat. Hist.* 108: 253–352.
- Gore, R. H., and L. G. Abele. 1976. Shallow water porcelain crabs from the Pacific coast of Panama and adjacent Caribbean waters. *Smiths. Contr. Zool.* 237: 1–30.
- Haig, J., T. S. Hopkins, and T. B. Scanland. 1970. The shallow water anomuran crab fauna of southwestern Baja California, Mexico. *Trans. San Diego Soc. Nat. Hist.* 16: 13–31.
- Hay, W. P., and C. A. Shore. 1918. The decapod crustaceans of Beaufort, N. C. and surrounding region. *Bull. U. S. Bur. Fish.*, Washington. 35: 369–475.
- Hazlett, B. A. 1966. Behavior of some deep-water hermit crabs (Decapoda: Paguridea) from the Straits of Florida. *Bull. Mar. Sci.* 16: 76–92.
- Hazlett, B. A., and A. J. Provenzano, Jr. 1965. Development of behavior in laboratory reared hermit crabs. *Bull. Mar. Sci.* 15: 616–633.
- Henderson, J. R. 1888. Report on the Anomura collected by H.M.S. *Challenger* during the years 1873–1876. Report on the scientific results of the voyage of H.M.S. *Challenger*. *Zoology* 23: 1–221.
- Holmes, S. J. 1900. Synopsis of the California stalk-eyed Crustacea. *Occ. Pap. California Acad. Sci.* 7: 1–262.
- Holthuis, L. B. 1959. The Crustacea Decapoda of Suriname (Dutch Guiana). *Zool. Verhandl.* 44: 1–296.
- McLaughlin, P. A. 1981. Revision of *Pylopagurus* and *Tomopagurus* (Crustacea: Decapoda: Paguridae), with the descriptions of new genera and species. Part I. Ten new genera of the Paguridae and a redescription of *Tomopagurus* A. Milne Edwards and Bouvier. *Bull. Mar. Sci.* 31: 1–30.
- Milne Edwards, A., and E. L. Bouvier. 1891. Observations générales sur les paguriens recueillis dans la mer des Antilles et le Golfe du Mexique, par le *Blake* et le *Hassler*, sous la direction de M. Alexandre Agassiz. *Bull. Soc. Philom.* (8) 3: 102–110.
- . 1893. Description des crustacés de la famille des paguriens recueillis pendant l'expédition. Reports on the results of dredging, under the supervision of Alexander Agassiz, in the Gulf of Mexico (1877–78), in the Caribbean Sea (1878–79), and along the Atlantic coast of the United States (1880), by the U.S. Coast Survey steamer “Blake” . . . *Mem. Mus. Comp. Zool. Harvard* 14: 1–172.
- Provenzano, A. J., Jr. 1959. The shallow-water hermit crabs of Florida. *Bull. Mar. Sci. Gulf Carib.* 9: 349–420.
- . 1961. Pagurid crabs (Decapoda Anomura) from St. John, Virgin Islands, with descriptions of three new species. *Crustaceana* 3: 151–166.
- Rosen, D. E. 1976. A vicariance model of Caribbean Biogeography. *Syst. Zool.* 24[1975]: 431–464.
- Sanchez, H. 1978. *Pylopagurus samariensis* sp. nov. (Crustacea, Anomura, Paguridae) de la costa de Caribe de Colombia. *Anal. Inst. Invest. Mar. Punta Betin* 9[1977]: 215–223.
- Schmitt, W. L. 1921. The marine decapod Crustacea of California, with special reference to the decapod Crustacea collected by the United States Bureau of Fisheries steamer “Albatross” in

- connection with the biological survey of San Francisco Bay during the years 1912–1913. Univ. Calif. Publ. Zool. 23: 1–165.
- Stimpson, W. 1859. Notes on North American Crustacea. Preprinted from Ann. Lyceum Nat. Hist. New York 7: 3–47.
- . 1862. Notes on North American Crustacea. Ann. Lyceum Nat. Hist. N.Y. 7: 49–93.
- Walton, B. C. 1954. The genus *Pylopagurus* (Crustacea: Anomura) in the Pacific with descriptions of two new species. Allan Hancock Pacif. Exped. 18: 139–172.
- Williams, A. B. 1965. Marine decapod crustaceans of the Carolinas. Fish. Bull. 65: 1–297.

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